

SMPTE STANDARD

for Television —

Type D-11 Data Stream and AES3 Data Mapping over SDTI



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1 Scope

This standard specifies the mapping of type D-11 compressed picture data stream into the SDTI payload area (SMPTE 305.2M) together with the mapping of four channels of AES3 data and time code data into H-ANC packets. Type D-11 compressed picture data stream mapping is defined for source coded picture rates of 24/1.001/P, 24/P, 25/P, 50-I, 30/1.001/P, and 60/1.001. For the transmission of compressed picture data coded at source picture rates of 25/P and 50/I, the SDTI interface operates at a frame rate of 25 Hz. For the transmission of compressed picture data coded at source picture rates of 30/1.001P and 60/1.001I, the SDTI interface operates at a frame rate of 30/1.001 Hz.

The transmission of compressed picture data coded at the source picture rates of 24/1.001/P and 24/P require the SDTI interface to operate at frame rates of 24/1.001 Hz and 24 Hz with the parameters defined in normative annex A and annex B of this standard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

AES3-1992, Digital Audio Engineering — Serial Transmission Format for Two-Channel Linearly Represented Digital Audio Data

ANSI/SMPTE 259M-1997, Television — 10-Bit 4:2:2 Component and $4f_{sc}$ Composite Digital Signals — Serial Digital Interface

ANSI/SMPTE 272M-1994, Television — Formatting AES/EBU Audio and Auxiliary Data into Digital Video Ancillary Data Space

SMPTE 291M-1998, Television — Auxiliary Data Packet and Space Formatting

SMPTE 305.2M-2000, Television — Serial Data Transport Interface (SDTI)

SMPTE 367M-2002, Television — Type D-11 Picture Compression and Data Stream Format

SMPTE RP 165-1994, Error Detection Checkwords and Status Flags for Use in Bit-Serial Digital Interfaces for Television

SMPTE RP 188-1999, Transmission of Time Code and Control Code in the Ancillary Data Space of a Digital Television Data Stream

3 General specifications

This standard specifies the mapping of the type D-11 data stream packets over SMPTE 305.2M (SDTI). The type D-11 data stream comprises packets of basic blocks containing compressed picture data and auxiliary picture data as specified in SMPTE 367M.

Four channels of 24-bit AES3 data are optionally mapped into the H-ANC space of the interface according to ANSI/SMPTE 272M. In addition, VITC may also be mapped into the H-ANC space.

The type D-11 data stream packets are grouped into six equal data segments of which the first three data segments are mapped onto the first field of the SDTI and the last three data segments are mapped onto the second field of the SDTI, as shown in figure 1 and table 1.

Figure 1 also includes the optional four channels of 24-bit AES3 data mapped into the H-ANC space. VITC data may also be mapped into the H-ANC space.

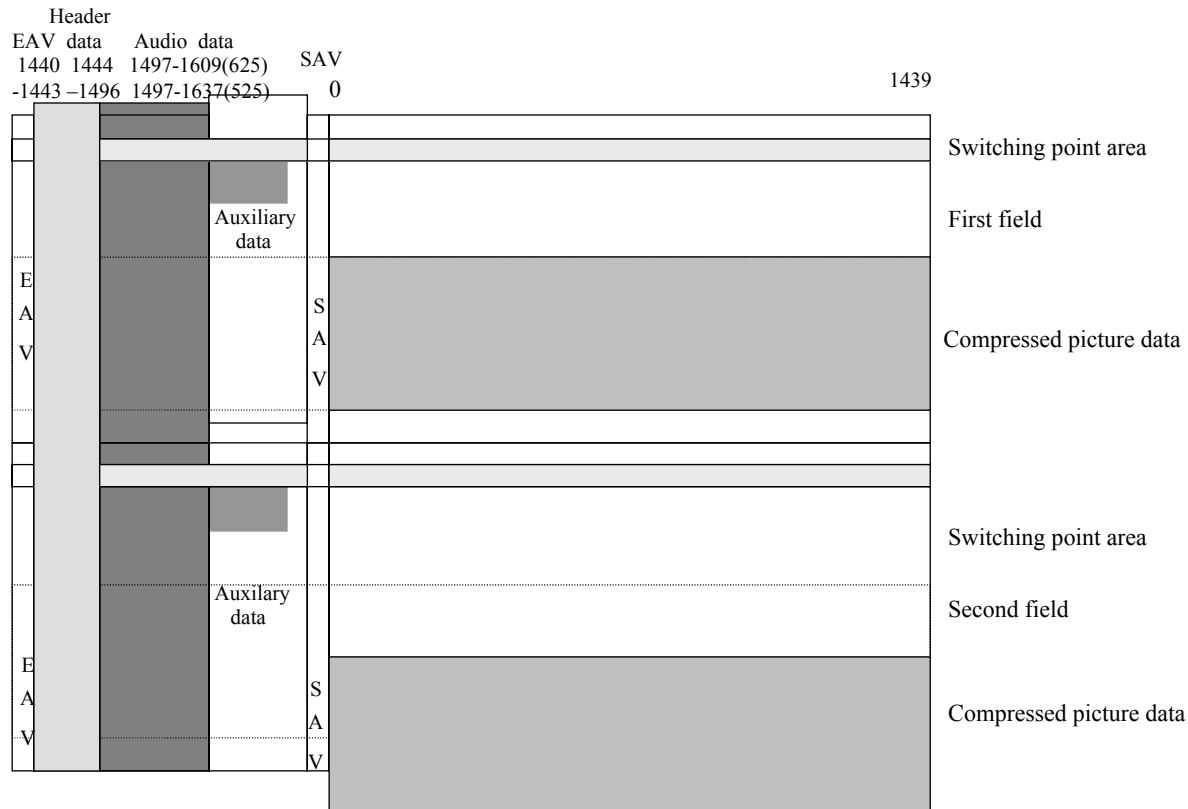


Figure 1 – SDTI mapping

Table 1 – Total number of lines and samples per line for each frame rate of the interface

Frame rate of the Interface	24/1.001 Hz	24 Hz	25 Hz	30/1.001 Hz
Total number of lines	525	625	625	525
Total number of samples per line	2145	1800	1728	1716
NOTE – The 24/1.001 Hz/24 Hz interface details are contained in annex A and annex B.				

4 Header data

4.1 Location of the header data

Header data shall be placed in H-ANC space and shall be located immediately following the EAV as shown in figure 1 and as defined by SMPTE 305.2M.

4.2 Structure of the header data

The structure of the Header data shall conform to SMPTE 305.2M and the contents shall be as shown in table 2.

Table 2 – Contents of header data (total words: 53)

Word No.	Data name	Value	Comment
0	ADF	000 _h	
1	ADF	3FF _h	
2	ADF	3FF _h	
3	DID	140 _h	
4	SDID	101 _h	
5	Data count	22E _h	Data: 46 words
6	Line No.0	XXX	
7	Line No.1	XXX	
8	Line No. CRC 0	XXX	
9	Line No. CRC 1	XXX	
10	CODE and AAI	101 _h	Payload: 1440 words, AAI: Unspecified
11 - 26	Destination address	200 _h	
27 - 42	Source address	200 _h	
43	Block type	241 _h	Fixed block size with ECC: 1438 words
44	CRC flag	101 _h	Payload CRC
45	Reserved 0	XXX	
46	Reserved 1	XXX	
47	Reserved 2	XXX	
48	Reserved 3	XXX	
49	Reserved 4	XXX	
50	Header CRC 0	XXX	
51	Header CRC 1	XXX	
52	Checksum	XXX	

5 Payload data

5.1 Location of the type D-11 stream data

The type D-11 data stream packets (comprising compressed picture and auxiliary data) shall be mapped into the payload space of the SDTI and shall be located as defined in table 3 and shown figure 1.

Table 3 – Location of compressed picture data

SDTI frame rate	24/1.001 Hz and 29.97 Hz	24 Hz and 25 Hz
Total number of interface lines	525	625
Horizontal mapping location	Samples 0 to 1439	
Vertical mapping Location		
First field	Lines 50 to 261	Lines 59 to 270
Second field	Lines 313 to 524	Lines 372 to 583

NOTE – The line numbering of the vertical mapping location is the same as that defined in ANSI/SMPTE 259M.

Each compressed picture data stream is divided into six equal segments, numbered 0 to 5, as defined in SMPTE 367M.

All the packets from segments 0 to 2 shall be mapped into the first field of the SDTI. All the packets from segments 3 to 5 shall be mapped into the second field of the SDTI.

Figure 2 defines how the data packets are mapped into each field of the SDTI.

6.2 Structure and contents of the SDTI payload lines

The SDTI payload lines shall contain the information defined in table 4 and figure 2.

Table 4 – Contents of compressed picture data

Word No.	Data name	Value	Comment
0	Data type	248 _h	Data type of type D-11
1	User data	200 _h or 1FE _h or 1FD _h	Valid data do not exist Valid data start line Valid data line
2 to 1437	User data	XXX	Type D-11 compressed picture data
1438	Payload CRC 0	XXX	
1439	Payload CRC 1	XXX	

Compressed picture data
= 224 W x 678 x 2 / Field

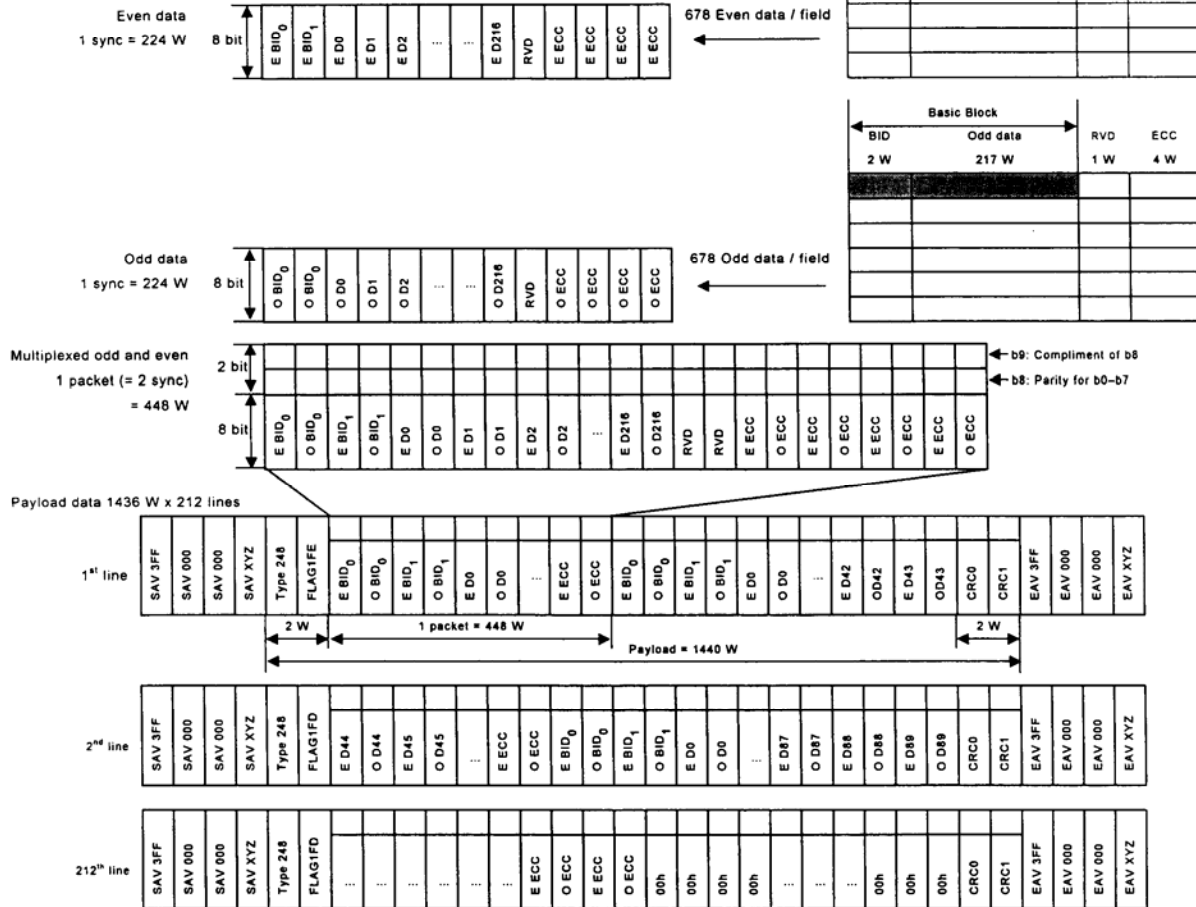


Figure 2 – Payload data stream structure

For each field of the SDTI, 1356 basic blocks of the type D-11 compressed picture data shall be mapped into the SDTI payload area on contiguous lines. In each SDTI field, 678 odd and 678 even data blocks are respectively selected from channel 0 and channel 1 as specified in the SMPTE 367M.

5.2.1 Basic block formatting

The compressed picture and auxiliary basic block format of the type D-11 compressed data shall conform to SMPTE 367M.

For the purpose of transporting the basic blocks over SDTI, 4 bytes of Reed-Solomon ECC shall be added to each basic block. Between the end of each basic block and the start of the ECC, a 1-byte reserved word shall be added.

The default value of the reserved word is zero.

Figure 3 illustrates the addition of the reserved word and the 4-byte RS ECC to a compressed picture basic block.

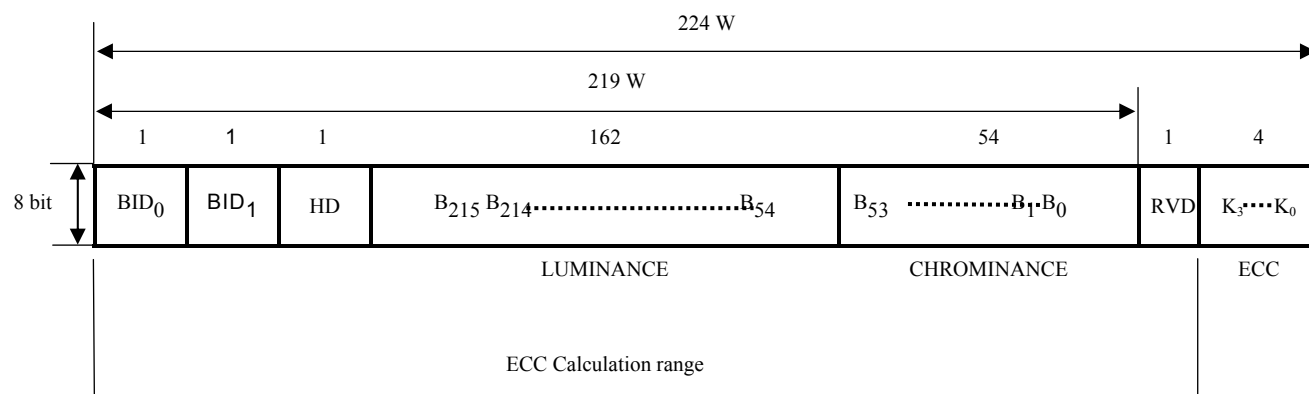


Figure 3 – Addition of reserved word and ECC to a compressed picture basic block

Figure 4 illustrates the addition of the reserved word and the 4-byte RS ECC to an auxiliary basic block.

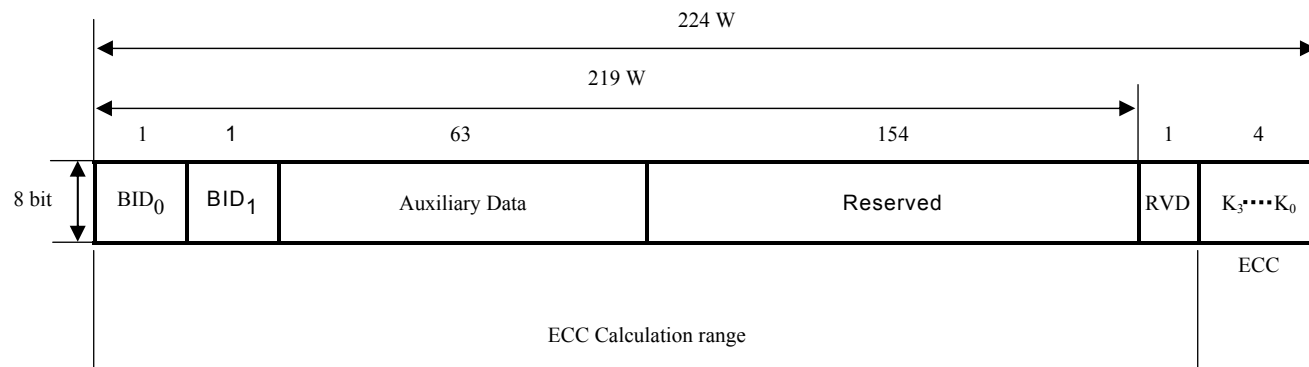


Figure 4 – Addition of reserved word and ECC to an auxiliary basic block

5.2.2 Error correction code (Reed-Solomon ECC)

Four words of Reed-Solomon ECC shall be added immediately after the reserved word (RVD).

The field generator polynomial of Reed-Solomon (RS) error correction code shall be as follows:

Galois field: GF(256)

Field generator polynomial: $X^8 + X^4 + X^3 + X^2 + 1$

where X^i are place-keeping variables in GF(2), the binary field. Note that the plus sign for this and the following equations indicates modulo 256 addition.

The code generator polynomial (GF(256)) is defined as:

$$G(X) = (X+1)(X+\alpha)(X+\alpha^2)(X+\alpha^3)$$

where α is given by 02_h in GF(256).

The RS check characters are defined as K_3, K_2, K_1, K_0 in

$$K(X) = K_3 X^3 + K_2 X^2 + K_1 X^1 + K_0,$$

obtained as the remainder after dividing polynomial $X^4 D(X)$ by $G(X)$,

where K_i are shown in figures 3 and 4, and $D(X)$ is the polynomial given by the following equation:

$$D(X) = \text{BID}_0 X^{219} + \text{BID}_1 X^{218} + \text{HD} X^{217} + \text{B}_{215} X^{216} + \text{B}_{214} X^{215} + \dots + \text{B}_1 X^2 + \text{B}_0 X^1 + \text{RVD}$$

The equation of full RS ECC code block ($C(X)$) is expressed as follows: $C(X) = X^4 D(X) + K(X)$

6 AES3 data

AES 3 data, if present, shall contain four audio channels in a single group and conform to the following mapping parameters.

6.1 Location of AES3 Data

Mapping of AES3 data onto the serial digital interface shall comply with SMPTE 272M-C (see table 5).

AES3 data comprises 24-bit words. The content of the AES3 data stream is not part of this standard.

Table 5 – Location of AES3 data

Frame rate	23.98Hz and 29.97Hz	24Hz and 25Hz
Total number of lines of the Interface	525	625
Horizontal sample count	Samples 1497 to 1637	Samples 1497 to 1609
Mapping of AES3 data	Lines 1 to 525 except for lines 10, 11, 273 and 274	Lines 1 to 625 except for lines 6, 7, 319 and 320

NOTE – This standard does not support the optional audio control data defined in ANSI/SMPTE 272M.

7 Auxiliary data

An auxiliary data packet may be used to map time code data (VITC). If present, the mapping shall comply with the following parameters.

7.1 Location of auxiliary data

Auxiliary data shall be located in the H-ANC space immediately following the extended data packet. The vertical position of each auxiliary data line shall be as shown in table 6. The structure and location of the H-ANC auxiliary data packets shall conform to SMPTE 291M.

Table 6 – Location of auxiliary data (vertical position)

Frame rate	24/1.001 Hz and 30/1.001 Hz	24 Hz and 25 Hz
Total lines	525	625
VITC	Line 14 and 277	Lines 10 and 323

7 VITC

If present, mapping of VITC data on to the serial digital interface shall comply with SMPTE RP188, and shall be as specified in table 7.

These VITC data shall have the same time code value as the VITC carried in the auxiliary data packets of SMPTE 367M.

Table 7- VITC H-ANC packet

Word No.	Name	Value	Comment
0 – 2	ADF	000 _h 3FF _h 3FF _h	
3	DID	260 _h	
4	DBN	260 _h	
5	Data count	110 _h	
6 – 21	UDW 0-15	XXX	
22	Checksum	XXX	

8 EDH

EDH checkwords may be added in H-ANC space and shall be located as defined by SMPTE RP 165.

Annex A (normative)**SDI and SDTI operation at 24/1.001 Hz (23.98... Hz)****A.1 Scope**

This annex provides information and specifications for an interface based on ANSI/SMPTE 259M and SMPTE 305.2M using a frame rate of 24/1.001 frames/s.

A.2 General

Based upon the introduction of 1920 x 1080 television equipment having a progressive capture frame rate of 24/1.001 frames/s, there is a need to define an interface for transporting and monitoring of the compressed signal over SDTI.

For the transporting of compressed signals coded at a source picture rate of 24/1.001 frames/s and formatted according to SMPTE 367M, the SDTI interface shall operate at 24/1.001 frames/s, interlaced, with parameters as defined in table A.1.

Table A1 - Interface sampling structure/formatting

Parameter	Value	Comments
Frame rate	24/1.001	Per second
Total number of lines	525	(As per ANSI/SMPTE 125M)
EAV/SAV structure	3FF,000,000,XYZ	As per ANSI/ SMPTE 125M and ANSI/SMPTE 259M
Signal levels		As per ANSI/SMPTE 259M
Serial bit rate	270 Mb/s	
Total number of words per line	2145	
User data words [payload]	1440	(As per SMPTE 305.2M)
Ancillary data words	697	Total line length minus user data and EAV/SAV words
AES3 data formatting	1497-1637	(As per ANSI/SMPTE 272M)
Auxiliary data formatting		(As per SMPTE 291M/SMPTE RP188)
EDH		(As per SMPTE RP 165)
Switching	Line 10	Note - As this is a segmented frame payload, switching shall only be on the frame boundary.
Compressed picture data mapping	Lines 50-261	Segments 0 to 2
	Lines 313-524	Segments 3 to 5
Auxiliary data	1638-2141	Note - The auxiliary data space of this format is greater than that for ANSI/SMPTE 259M.

Annex B (informative)

SDI and SDTI operation at 24Hz

B.1 Scope

This annex provides information and specifications for an interface based on ANSI/SMPTE 259M and SMPTE 305.2M using a frame rate of 24 frames/s.

B.2 General

Based upon the introduction of 1920 x 1080 television equipment having a progressive capture frame rate of 24.00 frames/s, there is a need to define an interface for transporting and monitoring of the compressed signal over SDTI.

For the transporting of compressed signals coded at a source picture rate of 24 frames/s and formatted according to SMPTE 367M, the SDTI interface should operate at 24 frames/s, interlaced, with parameters as defined in table B.1.

Table B.1 – Interface sampling structure/formatting

Parameter	Value	Comments
Frame rate	24	Per second
Total number of lines	625	(As per ANSI/SMPTE 125M)
EAV/SAV structure	3FF,000,000, XYZ	As per ANSI/SMPTE 125M and ANSI/SMPTE 259M
Signal levels		As per SMPTE 259M
Serial bit rate	270Mb/s	
Total number of words per line	1800	
User data words [payload]	1440	(As per SMPTE 305M)
Ancillary data words	352	Total line length minus user data and EAV/SAV words
AES3 data formatting	1497-1609	(As per SMPTE 272M)
Auxiliary data formatting		(As per SMPTE 291M/RP188)
EDH		(As per SMPTE RP 165)
Switching	Line 10	Note - As this is a segmented frame interface, switching must only be on the frame boundary.
Compressed picture data mapping	Lines 50-261	Segments 0 to 2
	Lines 313-524	Segments 3 to 5
Auxiliary data	1610-1796	Note - The auxiliary data space of this format is greater than that for ANSI/SMPTE 259M.

Annex C (informative)

Bibliography

ANSI/SMPTE 125M-1995, Television — Component Video Signal 4:2:2 — Bit-Parallel Digital Interface

SMPTE 12M-1999, Television — Audio and Film — Time and Control Code

SMPTE 368M-2002, Digital Television Tape Recording — 12.65-mm Type D-11 Format

ITU-R BT.709-4 (03/00), Parameter Values for the HDTV Standards for Production and International Programme Exchange